Tracking Stable Isotopes In a Regional Climate Model

Prudence N. Foster, Norman L. Miller, and Don DePaolo
Contact: Norman L. Miller, 510/495-2374, nlmiller@lbl.gov

RESEARCH OBJECTIVES

The ability to track isotopes through the water cycle in a climate model offers the opportunity to test the climate model itself, as well as to learn more about the water cycle. While several global climate models currently have isotope-tracking subroutines, there is to date no regional climate model with isotope tracing. Well-recognized advantages of a regional climate model, over a global one, include the ability to study the natural variability of local water budgets on scales of interest to water planning and ecological impact analyses. Adding tracing routines to the regional model will allow us to study the source of local rainfall and to better understand its sensitivity to climate and land surface changes. Moreover, *isotope* tracking throughout the water cycle will allow an unprecedented ability to test numerical precipitation schemes. Currently, climate models compare their precipitation predictions based primarily on the amount of rainfall. Since rain can develop in a variety of ways, simply getting the amount correct is not a guarantee that the model is actually simulating reality. By comparing the isotopic content of both deuterium and ^{18}O in the rainfall to observations on the scales at which observations can actually be extensively done (i.e., the regional scale), we will have much greater confidence in our rainfall schemes. Such intensive observations are already under way at the DOE Atmospheric Radiation Measurement-Cloud and Radiation Testbed (ARM-CART) site in Kansas (Machavaram et al., 2003), and we plan to make comparisons between our model and these observations.

APPROACH

Our approach has been to add isotope tracers to the community regional climate model MM5 (fifth generation Mesoscale Model). First of all, we have added a set of tracers that exactly copy the water cycle itself. Now, we are working on tracking “colored water”; for example, red water only enters the grid from the water surface of the Gulf of Mexico. We are testing various schemes for tracking the colored water through the processes of surface evaporation, mixing in the planetary boundary layer and cloud physics. The colored water will allow us to understand where water is coming from over the ARM/CART site. Once we have some assurance that these schemes are redistributing the colored water in a manner that we expect, adding the fractionation associated with various phase changes should be trivial. We will then be in a position to validate the model predictions against the observations of precipitation and vapor isotopic values measured in June 2000 at the ARM/ CART site.

ACCOMPLISHMENTS

To date, we have completed a map of the water cycle in MM5. We have reproduced the water cycle with an additional vector that can exactly follow the treatment of water or can be manipulated to test code development. We have also prepared the fractionation subroutines that will be needed when the code is ready to address the issue of isotopes.

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